WE CLAIM:

1. A method for aperturing a vertical-cavity surface-emitting laser (VCSEL) for increasing external quantum efficiency, the method comprising:

forming an aperture by selectively etching an active region between a first and a second reflecting surface;

said aperture reducing loss due to scattering in a cavity of a VCSEL, thereby increasing external quantum efficiency of said VCSEL; and

wherein the etching of the active region is at a rate substantially faster than a rate of etching for at least one of the first and second reflecting surface.

2. The method for aperturing a vertical-cavity surface-emitting laser (VCSEL) according to claim 1, wherein the etching is performed by a mixture comprised of a predetermined ratio of citric acid to hydrogen peroxide.

3. The method for aperturing a vertical-cavity surface-emitting laser (VCSEL) according to claim 2, wherein the predetermined ratio of citric acid to hydrogen peroxide is about 3:1.

4. A method for aperturing a vertical-cavity surface-emitting laser (VCSEL) for increasing external quantum efficiency, the method comprising:

lattice matching a first reflecting surface with a first substrate layer;

lattice matching a second reflecting surface with a second substrate layer;

etching an active region between the first and the second reflecting surface to form an aperture, said aperture having a predetermined size; and

said aperture reducing loss due to scattering in a cavity of a VCSEL, thereby increasing external quantum efficiency of said VCSEL.

5. The method for aperturing a vertical-cavity surface-emitting laser (VCSEL) according to claim 4, wherein the first reflecting surface is a first Distributed Bragg Reflector (DBR).

6. The method for aperturing a vertical-cavity surface-emitting laser (VCSEL) according to claim 4, wherein the second reflecting surface is a second Distributed Bragg Reflector (DBR).

7. The method for aperturing a vertical-cavity surface-emitting laser (VCSEL) according to claim 4, wherein the first substrate layer and the second substrate layer are of InP.

8. The method for aperturing a vertical-cavity surface-emitting laser (VCSEL) according to claim 4, wherein the etching is performed by a mixture comprised of a predetermined ratio of citric acid to hydrogen peroxide.

9. The method for aperturing a vertical-cavity surface-emitting laser (VCSEL) according to claim 8, wherein the predetermined ratio of citric acid to hydrogen peroxide is about 3:1.

10. A vertical-cavity surface-emitting laser (VCSEL) for increasing external quantum efficiency, the VCSEL comprising:

a first reflecting surface;

a second reflecting surface;

an active region;

an aperture formed by selectively etching the active region to a predetermined size in comparison to a size of at least one of the first and second reflecting surfaces; and

said aperture reducing a loss due to scattering in a cavity of a VCSEL, thereby increasing external quantum efficiency of said VCSEL.

11. The VCSEL according to claim 10, wherein the VCSEL further comprises at least one cladding layer.

12. The VCSEL according to claim 10, wherein the first reflecting surface is a first Distributed Bragg Reflector (DBR) and the second reflecting surface is a second Distributed Bragg Reflector (DBR).

13. The VCSEL according to claim 12, wherein the first DBR and second DBR are made of alternating layers of $Al_{a1}Ga_{1-a1}As_bSb_{1-b}$ and $Al_{a2}Ga_{1-a2}As_bSb_{1-b}$ approximately lattice matched to InP.

14. The VCSEL according to claim 13, wherein b is greater than about 0.5, a1 is greater than about 0.9, and a2 is less than about 0.3.

15. The VCSEL according to claim 12, wherein the first DBR and the second DBR are preferably undoped.

16. The VCSEL according to claim 15, wherein the n-type material is made of a mixture of lead and tellurium.

17. The VCSEL according to claim 10, wherein the aperture is formed by etching with a predetermined ratio of citric acid to hydrogen peroxide.

18. The VCSEL according to claim 10, wherein said ratio of citric acid to hydrogen peroxide is about 3:1.

19. The VCSEL according to claim 13, wherein the first DBR and the second DBR have between eighteen and thirty-five layers of $Al_{a1}Ga_{1-a1}As_bSb_{1-b}$ and $Al_{a2}Ga_{1-a2}As_bSb_{1-b}$.

20. The VCSEL according to claim 17, wherein the first reflecting surface is etched to a predetermined diameter by the citric acid and hydrogen peroxide.

21. The VCSEL according to claim 20, wherein the active region is etched at a rate substantially faster than a rate of etch applied to at least one of the first and second reflecting surfaces.

22. A vertical-cavity surface-emitting laser (VCSEL) for decreasing threshold current, the VCSEL comprising:

a first reflecting surface;

a second reflecting surface;

an active region with a first surface and a second surface;

a first cladding layer between the first reflecting surface and the first surface of the active region;

a second cladding layer between the second reflecting surface and the second surface of the active region;

an aperture formed by selectively etching the active region to a predetermined size in comparison to a size of at least one of the first and second reflecting surfaces; and

said aperture reducing a loss due to scattering in a cavity of a VCSEL, thereby decreasing threshold current in said VCSEL.

23. The VCSEL according to claim 22, wherein the first surface of the active region has a tunnel junction.

24. The VCSEL according to claim 22, wherein the first cladding layer and the second cladding layer are made of InP.

25. The VCSEL according to claim 22, wherein the first reflecting surface is a first Distributed Bragg Reflector (DBR) and the second reflecting surface is a second Distributed Bragg Reflector (DBR).

26. The VCSEL according to claim 25, wherein the first DBR and second DBR are made of alternating layers of $Al_{a1}Ga_{1-a1}As_bSb_{1-b}$ and $Al_{a2}Ga_{1-a2}As_bSb_{1-b}$ approximately lattice matched to InP.

27. The VCSEL according to claim 26, wherein b is greater than about 0.5, a1 is greater than about 0.9, and a2 is less than about 0.3.

28. The VCSEL according to claim 25, wherein the first DBR and the second DBR are doped uniformly with n-type material.

29. The VCSEL according to claim 27, wherein the n-type material is made of tellurium.

30. The VCSEL according to claim 22, wherein the aperture is formed by etching through a predetermined ratio of citric acid to hydrogen peroxide.

31. The VCSEL according to claim 22, wherein said ratio of citric acid to hydrogen peroxide is about 3:1.

32. The VCSEL according to claim 26, wherein the first DBR and the second DBR have between eighteen and thirty-five layers of $Al_{a1}Ga_{1-a1}As_bSb_{1-b}$ and $Al_{a2}Ga_{1-a2}As_bSb_{1-b}$.

33. The VCSEL according to claim 30, wherein the first reflecting surface is etched to a predetermined diameter by the citric acid and hydrogen peroxide.

34. The VCSEL according to claim 33, wherein the first reflecting surface is etched at a rate slower than an etch rate of the active region.

35. A method for aperturing a vertical-cavity surface-emitting laser (VCSEL) for increasing external quantum efficiency and decreasing threshold current, the method comprising:

forming an aperture by selectively etching an active region between a first and a second reflecting surface, said aperture having a predetermined size and formed having an opening; and

said aperture reducing loss due to scattering in a cavity of a VCSEL, thereby increasing external quantum efficiency and decreasing threshold current of said VCSEL.

36. The method for aperturing a VCSEL according to claim 35, wherein the VCSEL further comprises at least one cladding layer.

37. The method for aperturing a VCSEL according to claim 35, wherein the first reflecting surface is a first Distributed Bragg Reflector (DBR) and the second reflecting surface is a second Distributed Bragg Reflector (DBR).

38. The method for aperturing a VCSEL according to claim 37, wherein the first DBR and second DBR are made of alternating layers of $Al_{a1}Ga_{1-a1}As_bSb_{1-b}$ and $Al_{a2}Ga_{1-a2}As_bSb_{1-b}$ approximately lattice matched to InP.

39. The method for aperturing a VCSEL according to claim 38, wherein b is greater than about 0.5, a1 is greater than about 0.9, and a2 is less than about 0.3.

40. The method for aperturing a VCSEL according to claim 35, wherein the first DBR and the second DBR are doped uniformly with n-type material.

41. The method for aperturing a VCSEL according to claim 40, wherein the n-type material is made of tellurium.

42. The method for aperturing a VCSEL according to claim 35, wherein the aperture is formed by etching through a predetermined ratio of citric acid to hydrogen peroxide.

43. The method for aperturing a VCSEL according to claim 35, wherein said ratio of citric acid to hydrogen peroxide is about 3:1.

44. The method for aperturing a VCSEL according to claim 38, wherein the first DBR and the second DBR have between eighteen and thirty-five layers of $Al_{a1}Ga_{1-a1}As_bSb_{1-b}$ and $Al_{a2}Ga_{1-a2}As_bSb_{1-b}$.

45. The method for aperturing a VCSEL according to claim 42, wherein the first reflecting surface is etched to a predetermined diameter by the citric acid and hydrogen peroxide.

46. The method for aperturing a VCSEL according to claim 45, wherein the first reflecting surface is etched at a rate slower than an etch rate of the active region.

47. The method for aperturing a VCSEL according to claim 40, wherein the doping level for the first DBR and the second DBR is about 10^{18} /cm^3 near the cavity.

48. The method for aperturing a VCSEL according to claim 40, wherein the doping level for the first DBR and the second DBR is about 4×10^{18} /cm^3 substantially away from the cavity.

49. The method for aperturing a VCSEL according to claim 40, wherein the threshold current is reduced by more than about 20%.

50. The method for aperturing a VCSEL according to claim 40, wherein the quantum efficiency is increased by more than about 10%.

51. A method for aperturing a vertical-cavity surface-emitting laser (VCSEL) for increasing external quantum efficiency and decreasing threshold current, the method comprising:

coating a wall of at least one reflecting surface in a VCSEL with a dielectric;

forming an aperture by selectively etching an active region of a VCSEL with an etchant; and

said aperture reducing loss due to scattering in a cavity of a VCSEL, thereby increasing external quantum efficiency and decreasing threshold current of said VCSEL.

52. The method for aperturing a VCSEL according to claim 51, wherein the etchant is composed of citric acid and hydrogen peroxide in a predetermined ratio.

53. The method for aperturing a VCSEL according to claim 51, wherein the etchant is either H_3PO_4, or H_2O_2, or H_2O, or any combination thereof.

54. A method for aperturing a vertical-cavity surface-emitting laser (VCSEL) for increasing external quantum efficiency, the method comprising:

selectively etching an aperture between a first and a second surface;

said aperture designed to reduce loss due to scattering in a cavity of a VCSEL, thereby increasing external quantum efficiency of said VCSEL; and

wherein the aperture is etched at a rate substantially faster than a rate at which at least one of the first and second surfaces is etched.

55. A method for aperturing a vertical-cavity surface-emitting laser (VCSEL) for increasing external quantum efficiency, the method comprising:

selectively etching an aperture between a first and a second surface;

wherein:

at least one of the first and second surfaces has a taper;

at least one of the first and second surfaces is formed from a first material which is etched at a rate substantially faster than the rate at which a second material forming the aperture is etched; and

wherein a selectivity of the etching between the first material and the second material is substantially greater than unity.

56. The method according to claim 55, wherein the first material is a compound having InGaAlAs.

57. The method according to claim 55, wherein the second material is a compound having InAlAs.

58. The method according to claim 55, wherein the first and the second surface is made of InP.

59. The method according to claim 55, wherein the first material is InP and the second material contains As and is lattice matched to InP.

60. The method according to claim 59 wherein the first and second materials are etched using an etchant containing citric acid.

61. A semiconductor laser comprised of:

photon reflecting mirrors;

an active region sandwiched between the mirrors; and

a first etched aperture lattice matched to InP and having a lateral surface area less than that of at least one of the mirrors.

62. The laser of claim 61 wherein the material of the aperture includes As.

63. The laser of claim 62 wherein the material of the aperture includes a group V element.

64. The laser of claim 62 wherein the material of the aperture includes an element of the group including: Al, Ga, and In.

65. The laser of claim 61 further comprising a second etched aperture lattice matched to InP, having a lateral surface area less than that of at least one of the mirrors, and separated from the first aperture by a layer of InP.

66. The laser of claim 65 wherein the first aperture confines the current and the second aperture confines the optical mode.